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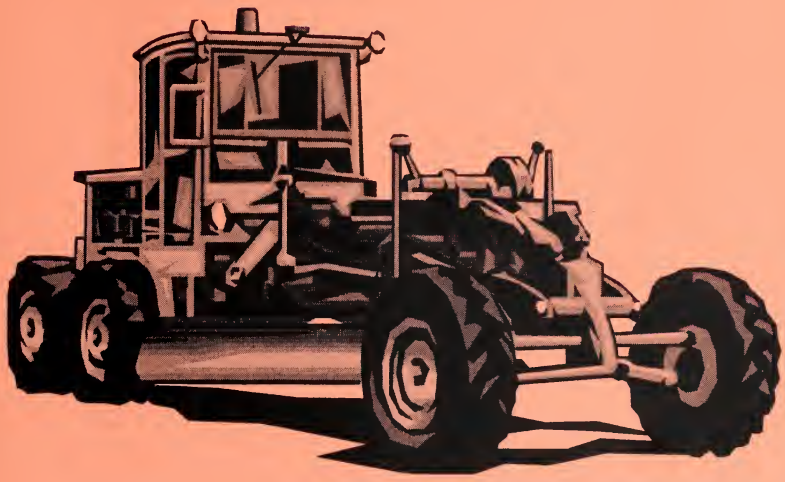
MOTOR GRADER
OPERATION AND MAINTENANCE MANUAL



MONTANA DEPARTMENT OF TRANSPORTATION
Maintenance and Equipment Division

2005

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FORWARD

This manual was prepared for the field maintenance employees who are or will be responsible for the operation and daily maintenance of the Department's motor graders. The information in this manual is general and needs to be used with the *Operator's Manual.*

PURPOSE

The purpose of this manual is to assist beginning and experienced operators in operation, safety, and maintenance of the motor grader. This manual provides a knowledge base for potential operators and a resource for present operators. The manual is based on the fact, an aware, well informed operator insures good maintenance of our highway system.

GENERAL RESPONSIBILITY

This manual provides basic information and department policy for using the motor grader. It is your responsibility to know the information in this manual and in the *Operator's Manual.*

To become a good operator, you need to know your equipment, proper operating procedures, proper safety procedures, proper preventive maintenance, department policies, and your roads. You also need hours of practice in the grader.

The motor grader is one of the most important machines used in highway maintenance. Well maintained equipment allows you to do your job with pride. You are not expected to be a trained mechanic. You are expected to do daily maintenance checks, follow preventive maintenance procedures, and recognize mechanical defects as they occur.

Safety is an important part of motor grader operation. Manufacturers have incorporated into the motor graders easier controls and safety features. You, the careful operator, are the greatest safety device there is. You can avoid situations that cause accidents.

Be sure to read the safety precautions in this manual and in the manufacture's Operating Manual. Study the precautions and warning decals on your machine. Practice safe operation. Think ahead. Be aware of what is happening around you.

Safety is up to you.

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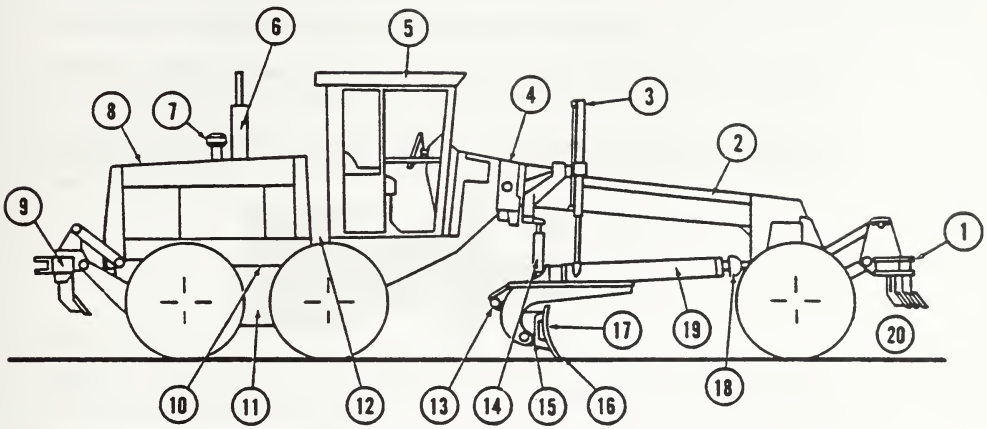
TERMINOLOGY



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CHAPTER 1

MOTOR GRADER BASICS

1.1 MOTOR GRADER OPERATION COMMON TERMS:

ARTICULATED: Jointed, articulated machines will pivot in the middle of machine for better traction and handling.

BLADE ANGLE: Refers to angle of blade in relationship to mainframe. The frame represents a 180 degree or a straight line. The moldboard will form angles with the frame. (Figure 1.1)

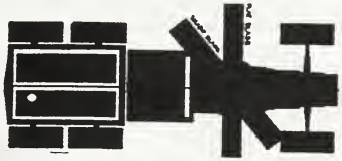


Figure 1.1

CIRCLE: Circular part of motor grader located under the frame. Moldboard with cutting blade is attached to the circle.

CROWN: Build up middle of road bed so that water will flow to sides.

CUTTING EDGE: Blade.

HEEL OF THE BLADE: Following end of the blade.

ICE BLADES: Serrated or saw tooth cutting edges.

LUGGING: Trying to move forward in a gear that is too high for the work load or the terrain.

MOLDBOARD: Attached to the circle and is pulled by a draw bar fastened in the center of the front wheels. The blade is attached to it.

SCARIFY: To loosen the road surface.

TANDEM DRIVE: All four rear wheels are driving and have constant traction.

TOE OF THE BLADE: Leading end of the blade.

WHEEL LEAN: Lean of front wheels to the left or right, used to stabilize the grader and assist in turning.

WINDROW: A ridge of loose material, also known as a berm.

NOTE: The control levers and blade angles are defined under the operation section.

1.2 GENERAL INFORMATION

The motor grader is one of the most versatile pieces of heavy equipment in highway maintenance. The motor grader has been designed to level or smooth an area. It has a long wheel base that can span short depressions or humps.

The grader has a centrally located blade that can be angled to cast out on either side. The moldboard mounted on the circle allows the blade to be adjusted for height, angle, pitch, and reverse direction. This ability to maneuver allows the motor grader to cut, shape, spread, and fine grade.

NOTE: More information about blading is given in Chapter 4.

The motor grader can be used on several types of highway maintenance jobs. It can be used for making mix, laying a patch, widening shoulders, cutting back slopes, ditching, scarifying, drying material, and plowing snow.

Operating the motor grader is different from other types of vehicle. When operating the motor grader, sit in the seat with the seat belt on. Sitting down allows the operator to feel the movement of the machine. Before starting to move, raise the blade or moldboard. *The Operator's Manual* will give instructions on how to get your particular model moving.

When moving, shifting is possible. As a rule, do shifting on fairly level surfaces. It may not be possible to get into another gear when shifting going up or downhill. To shift from a lower to higher gear, lower the engine RPM.

Caution: Always come to a complete stop before changing from a forward gear to a reverse gear.

The foot accelerator and decelerator pedals control the engine speed. The accelerator and decelerator pedals work together with the engine speed control lever. With the engine speed control lever in slow position, the engine speed may be raised by depressing the accelerator pedal. When accelerator pedal is released, the engine speed will return to the setting determined by the engine speed control lever.

Avoid unnecessary speed, particularly on rough ground. Do not spin the wheels as this is hard on the machine and tires and also makes the surface rough. Start out slowly and do not jerk the machine.

Drive the machine in a straight line by watching ahead, lining up with some object, and driving toward it. Front wheel lean can usually be used to steer the motor grader on level ground. Wheel lean also helps to keep the motor grader straight when pulling a load by counter acting load pull.

Operating speed affects the quality of work. When ditching or blading, do not hurry. Higher speeds could cause the grader to bounce and gouge the surface rather than smooth it. In extreme cases, bouncing could cause the operator to lose control of the grader, producing a potential accident situation.

an the wheels in the direction the machine is suppose to turn. Wheel lean can help counter side-draft created by the pull of the blade when it is loaded. When working on a slope, the wheels are leaned up slope to help hold the machine in a straight line. Remember that leaning the front wheels will lower the blade slightly. When moving material left, lean wheels opposite for traction on the front end.

1.3 TURNING AROUND

When turning around, wheels should be leaned in the direction in which the turn is being made. Stop the grader and shift gears. Complete your turn. You will find that when you leave the wheels on grade and lean in the direction of the turn, the grader will make the turn with ease. Turning around should be done in the borrow pit to avoid tearing the edge of the roadway with tandems.

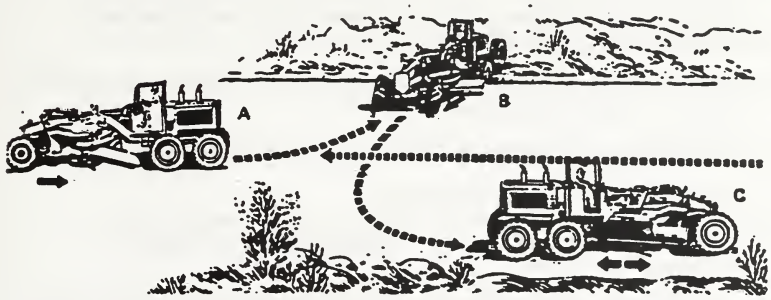


Figure 1.2

1.4 OPERATING AN ARTICULATED MOTOR GRADER

Articulated motor graders have greater application range and productivity than rigid-frame motor graders. Three operating modes--straight, articulated and crab--may be used for efficient output in maintenance operations. (Figure 1.2) Straight mode is used for long-pass blading, dry-ditch cleaning, blading shoulders, and scarifying. Articulated mode is used for short turns, V-ditch construction, spreading material, operating in tight areas, and cutting a high bank. Crab mode is used in heavy windrowing operations, wet ditch cleaning, and cutting a bank on a gentle slope.

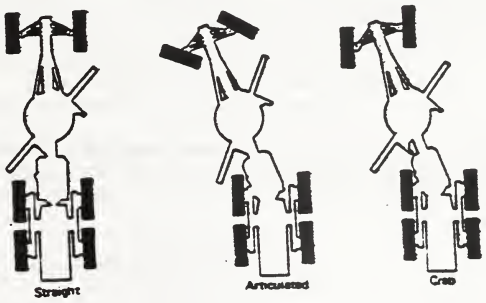


Figure 1.3

Articulation can be used to help with steering. Place the grader in articulated mode. With the rear module on center and without moving the steering wheel, the motor grader can be steered to the left or right by articulating the rear module sharply. Lean wheels when turning the grader. Leaning the wheels will decrease the turning radius. To turn right, lean the wheels to the right and articulate to the right. To turn left, lean the wheels to the left and articulate to the left. When the front tends to veer out of line, articulate the rear module in the opposite direction enough to overcome this tendency. Then hold the machine in line. Watch heel of blade and tires.

1.5 GENERAL OPERATING TIPS

Here are some general operating tips to help prolong machine life and reduce break downs.

- Keep dirt out of engine openings by wiping off dirt and grease before opening filler necks and dipsticks.

- Lubricate the pivot points according to ***Operator's Manual***. Use graphite on the grader's circle if recommended.

- Be sure that containers used to carry oil and fuel are kept clean.

- Don't pour cold water in a hot engine.

- It is always a good idea to fuel at the end of the shift, to prevent condensation in the tank.

- When not in use, put the blade on the ground. If the blade is left up at night, place two short blocks underneath it. The grader can be pulled easily from off the blocks.

1.6 SAFETY PROCEDURES

The equipment operator prevents accidents. Manufacturers have incorporated into the motor graders easier controls and safety features. The safety of you and those around you is up to you. You are the only person who can avoid situations that cause accidents. Planning ahead, staying alert, and operating sensibly will prevent problems.

Only well-trained, designated operators should run the equipment. The operator must be extremely careful in the operation of the motor grader. To help prevent accidents, observe the following safety rules at all times.

Use Common Sense and Good Judgment!

This section contains some of the safety procedures used for the motor grader. Other safety procedures are included through out the text under the heading of Caution.

1.6.1 General Safety Procedures:

1. Know the safety and operating information in the *Operator's Manual.* Know where all controls are located and how they operate the machine.

2. Obey the decals located on the grader in areas of possible danger.

3. Always face machine when getting in or out of the grader.

4. Never jump from any machine.

5. Facing the machine, always maintain a firm grip on the hand holds while entering or leaving the machine, until seated or firmly on the ground.

6. Clean shoes of slippery materials to prevent slipping on steps or pedals.

7. Pull the keys before servicing or repairing grader. Pull keys at the end of operation.

8. Never permit anyone to ride on the grader. Only the operator should ride in the grader.

9. Use machine's safety equipment. It's there for your protection. Sit in the seat. **USE THE SEAT BELTS.**

1.6.2 Preventive Maintenance and Servicing Safety Procedures:

1. Do pre-operation check daily.

2. Never operate the motor grader in a closed shed or garage.

3. Keep the operator's platform clean.

4. Do not oil, grease, or adjust the machine when the engine is running.

5. When working on raised hydraulic equipment, block it securely.

6. Always disconnect the battery ground strap before making adjustments on the engine or electrical equipment. This will prevent fire hazards, explosions, and accidental operation of the starter.

7. Do not use defective or unsafe equipment.

1.6.3 Operating Safety Procedures:

1. Survey under or around the machine before starting to make sure no one is there.

2. Honk horn before moving the grader.

3. Look behind grader, at all times, before backing up.

4. Always check overhead clearance, especially when transporting the unit. (Know your maximum height before transporting.)

5. Never coast the machine with the transmission in neutral or with the clutch disengaged. Maintain a ground speed consistent with conditions.

7. Avoid operating too close to banks or overhangs.

8. Drive at speeds slow enough to insure safety and complete control, especially in rough terrain.

9. Increase the power gradually when pulling a heavy load or when driving out of a ditch or excavation.

10. Reduce speed when making a turn or applying brakes.

11. Always carry the blade high and toed to the off traffic side when deadheading down the road.

12. Cross obstacles at an angle and at a slow speed. Be alert when going over obstacles.

13. Bring motor grader to a complete stop before shifting from a forward gear to a reverse gear, or from a reverse gear to a forward gear.

1.6.4 Shut Down Safety Procedures:

1. Park on level ground, place in neutral, and set parking brake.

2. Lower the blade to the ground or place on blocks.

3. When shutting down, cool the engine 3 to 5 minutes.

4. Shut off the engine when refueling. Do not smoke.

5. Take the keys out of the grader.

6. Clean out the cab at the end of each day.

7. Make an inspection of the grader after each shift. Report any problems to supervisor. Enter information on EMS-1.

8. When leaving machine at job site always blade off a spot big enough to park machine on in case of grass fire. Don't leave the engine running unattended.

On-the-Job Training Sheets

OJT # 1 Turning Around

_____ 1. Lean front wheels in direction of turn.

NOTE: When a motor grader makes a number of passes over a distance of less than 1,000 feet, it is usually more efficient to back the grader the entire distance to the starting point than to turn around and continue working from the far end. But, if your passes cover a distance of 1,000 feet or more, as in snow removal, it is more efficient to turn the grader around and start blading from the far end to the starting point. The combined maneuvering advantages of leaning wheels and tandem drive are a big help in turning the machine around.

_____ 2. Lean front wheels in direction of turn.

_____ 3. Back across the ditch or roadway.

_____ 4. Stop motor grader and shift gears when shifting from low to reverse or from reverse to low.

_____ 5. Complete the turn.

NOTE: You will find that when you leave the wheels on grade and lean in the direction of the turn, the motor grader will make the turn with ease. Always back across the road or ditch and leave the front wheels on the roadway.

OJT # 2 Operating an Articulated Motor Grader

_____ 1. Follow pre-start inspection procedure.

_____ 2. Review *Operator's Manual* for specific instructions.

_____ 3. Facing the grader, mount motor grader using steps and grabbing irons.

_____ 4. Sit in operator's seat and secure seat belt.

_____ 5. Follow procedure for starting engine; allow proper warm up.

_____ 6. Check all gauges and controls for proper functioning.

_____ 7. Check *Operator's Manual* for idle speed.

_____ 8. Raise all implements.

_____ 9. Position gearshift lever in proper gear.

_____ 10. Release parking brake; proceed to work area.

_____ 11. With motor grader in straight mode, move forward through gearshift range.

_____ 12. Operate in articulated mode.

_____ 13. Steer by articulating.

NOTE: With the rear module on center, without moving the steering wheel, the motor grader can be steered to the left or right by sharply articulating the rear module gradually. Watch front tandem tires and heel of blade.

_____ 14. Turn motor grader around.

_____ A. Lean wheels as you turn motor grader; turn right articulate right.

_____ B. Turn left and articulate left.

_____ C. Turn right and articulate right.

_____ D. Articulate straight.

_____ E. Never articulate with tandem axle lock on. This could damage the drive line.

_____ 15. Place in straight mode and stop motor grader.

_____ 16. Return to parking area; stop and secure motor grader; follow shutdown procedure.

_____ 17. Dismount, using grab irons and steps.

_____ 18. Make final visual inspection for leaks, broken, worn, loose, or missing parts.

_____ 19. Enter appropriate data on EMS-I.

_____ 20. Report time and equipment for appropriate MMS activity number.

CHAPTER 2

INSPECTIONS AND PREVENTIVE MAINTENANCE

Checks are performed every day prior to start-up, during operation, and after shut-down. This is called preventive maintenance (PM).

2.1 PRE-START INSPECTIONS:

1. Make a walk-around visual inspection for leaks, broken, worn, or missing parts.

2. Check major components:

   ✓ Circle drive for leaks.

   ✓ Pivot point and blade slides for dirt or debris buildup.

   ✓ Blade linkage for excessive play, damage, loose or missing parts.

3. Clean and lubricate with graphite the blade circle and side shift cylinder according to the recommendations in the *Operator's Manual.*

4. Check blade for loose bolts and amount of cutting edge remaining.

5. Clean all grease fittings and lubricate according to specifications in the ***Operator's Manual.*** Cleaning should include cylinders, pivot points, and drawbar bale.

Caution: Lock safety bar when working in pivot area. Check with the attachments down. Cycle the steering wheel to relieve pressure in the hydraulic system.

6. Check hydraulic system for leaking lines and connections, bent, or kinked lines, and lines rubbing against other parts. Check for loose, worn, or broken parts. Check hydraulic oil level.

Caution: Never make repairs or tighten hydraulic hoses or fittings when the system is under pressure, the engine is running or the cylinders are under a load.

7. Check engine oil levels and condition. Add the correct weight of oil if needed. Enter on EMS-1.

Caution: Keep dirt out of engine openings by wiping off dirt and grease before opening filler necks and dipstick tube. Be sure that containers used to carry oil and fuel are kept clean.

8. Check cooling system. Check coolant level in the radiator. Add coolant if needed. Check radiator cap, hoses, clamps, and fan belts.

Caution: Do not remove radiator pressure when the radiator is hot.

9. Check transmission oil level on power shift transmission.

10. Check for transmission leaks.

11. Check air restriction indicator. Check air cleaner and connections. Dump the dust cup if the machine has one.

Do other checks on OJT List below.

2.2 START-UP PROCEDURES:

Caution: Always face the machine and use hand hold when entering and leaving the machine.

1. Sit in the seat.

2. Set parking brake and put transmission into neutral.

Caution: Use cold weather starting fluid carefully. Wait at least ten minutes before using starting fluid if you have attempted to start the engine a manifold heater. Crank the engine 5-10 seconds before attempting to use manifold heater if you have used starting fluid first.

3. Crank the engine. Check ***Operator's Manual*** for procedures for your motor grader.

Caution: Don't crank engine for more than 20 seconds. The starter will overheat and fail. If the engine doesn't start after 20 seconds of cranking, let it cool off for at least 2-3 minutes before trying again.

4. Check the oil pressure gauges as soon as the engine starts. Shut down if pressure does not come up.

5. Idle engine from 3-5 minutes. Check recommendations in the ***Operator's Manual***.

6. Check all gauges to see if they are operating.

7. Check all controls and brakes for proper functioning.

8. Recheck lights, back-up alarms, or other warning and safety devices.

2.3 DURING OPERATION PROCEDURES:

1. Sit in the seat and fasten seat belts.

2. Sound horn before moving.

3. Check back up alarm.

4. Listen for unusual noise.

5. Be alert for problems regarding steering and braking.

Caution: Completely stop before reversing gears.

2.4 SHUT-DOWN PROCEDURES:

1. Park the motor grader on level ground if possible.

2. Lower all hydraulic equipment to the ground, place transmission into neutral, and set the parking brake.

3. Reduce engine speed and cool engine 3-5 minutes before shutting down. Check ***Operator's Manual*** for specific recommendations. This applies any time the unit is shut down.

Caution: Turn the machine off when refueling. Don't smoke.

4. Fuel the motor grader with the engine shut down.

5. Clean the cab. Use hand holds to get out of grader.

6. Make a walk-around check:

   ✓ Loose, worn or broken parts.

   ✓ Hydraulic system hose and connection leaks.

   ✓ Any oil, grease, coolant, or fuel leaks.

   ✓ Blade wear.

7. Clean asphalt off the moldboard, pivot points.

Caution: Don't leave machine unattended with the engine running. Remove key when working on grader.

8. Report any problems to supervisor.

2.5 SERVICING PROCEDURES:

> **Caution: Lower all raised equipment before servicing grader. If any equipment needs to be raised for service, block the equipment securely. Lock pivot points.**

1. Lube steering, suspension, controls, pivot points, drive shafts, hinge pins, bucket pins, and circle pivot.

NOTE: Graphite is usually used on the circle. Follow specific instructions in *Operator's Manual* for your grader model.

2. Change oil and filter.

3. Check transmission oil level, battery water level, hydraulic reservoir, oil level, brakes, radiator coolant level and hoses, all belts for wear, lights-operating and safety, tires for breaks, wear, and proper inflation, dash instruments and gauges, back-up alarm.

> **Caution: Always disconnect the battery ground strap before making adjustments on the engine, or electrical equipment and before welding on any part of the unit.**

4. Inspect all hydraulic hoses and fittings for wear or leakage, exhaust system.

> **Caution: Relieve all pressure before opening or removing any hydraulic pressure caps, lines, valves, and fittings.**

5. Service air cleaner

2.6 CHANGING THE BLADE:

The on-the-job training sheet covers the procedures for changing a blade.

On-The-Job Training Sheets

OJT #3 Pre-Start Inspection and Maintenance Procedures

_____ 1. Make walk-around visual inspection for leaks, breaks, wear, and missing parts.

NOTE: Equipment defects should be corrected immediately or reported to the proper authority. Don't operate defective equipment.

_____ 2. Clean all grease fittings and lubricates according to specifications in the ***Operator's Manual***. (Cleaning includes cylinders, pivot points, and drawbar bale.)

_____ 3. Check hydraulic system for leaking lines and connections, bent or lines rubbing against other parts.

_____ 4. Drain condensate from air tanks and fuel sight bowls.

_____ 5. Check engine oil level, add oil if needed, enter amount on EMS-1.

_____ 6. Check engine coolant level, add coolant if needed. (50/50 mixture.)

_____ 7. Check belts for tension and condition.

_____ 8. Check battery connections for tightness and corrosion.

_____ 9. Check battery electrolyte level, add water if needed.

_____ 10. Check electrical wire connections and insulation.

_____ 11. Check air cleaner restriction indicator, replace filter if necessary, empty dust cup.

_____ 12. Check fuel level.

_____ 13. Check tires and wheels.

_____ 14. Clean windshield and mirrors, adjust mirrors.

_____ 15. Remove trash from the cab.

_____ 16. Check safety devices.

_____ 17. Check lights.

_____ 18. Check circle drive for leaks.

_____ 19. Clean circle, lubricate according to factory recommendations.

_____ 20. Check blade and end bits for wear, damage, loose, or missing parts.

_____ 21. Check blade linkage for excessive play, damage, loose. or missing parts.

_____ 22. Check pivot points and blade slides for dirt or debris buildup.

OJT# 4-Start, Operate, Shut-down, and Secure.

I. Procedures for starting engine and operating motor grader.

_____ 1. Follow pre-start inspection procedures.

_____ 2. Review ***Operator's Manual*** for specific instructions.

_____ 3. Mount motor grader, using steps and grabbing irons.

_____ 4. Sit in operator's seat.

_____ 5. Check to see if parking brake is set, grader is in neutral.

_____ 6. Place all controls in hold, neutral, or off position.

_____ 7. Start engine.

NOTE: In cold weather, check *Operator's Manual* for cold-weather starting procedures.

_____ A. Move engine-speed control to one-third position and depress accelerator pedal.

_____ B. Depress oil-pressure-bypass switch when applicable, turn key to cranking position.

_____ C. Release key when engine starts. Do not crank engine for more than twenty seconds. Allow starter to cool for at least two-three minutes before attempting to start it again.

_____ D. Release bypass switch when lubricating oil reaches operating pressure.

_____ 8. Check all gauges.

_____ 9. Allow engine to warm up.

_____ 10. While parking brake is set, operate all equipment controls possible.

Example: Raise and lower blade, shift blade, tilt blade, raise and lower right and left blade ends, rotate circle, shift circle, raise and lower scarifier or accessories, lean wheels, articulate.

NOTE: See *Operator's Manual* for specific instructions.

_____ 11. Check *Operator's Manual* for throttle settings. Low idle may not be recommended for some models of motor graders.

_____ 12. Raise all implements.

_____ 13. Gradually depress accelerator.

_____ 14. Shift gearshift level in proper speed ranges as motor grader moves forward.

NOTE: Downshift one gear at a time. When downshifting under a load, increase engine speed to match ratio of lower gear.

II. Procedures for Stopping Grader

_____ 15. Decrease engine speed by depressing decelerator.

_____ 16. Apply pressure to brake pedal.

_____ 17. Disengage clutch if applicable.

_____ 18. Shift gear shift level to neutral.

_____ 19. Shift range-shift lever to neutral

NOTE: Bring grader to a complete stop before shifting from forward to reverse gears or from reverse to forward gears.

NOTE: When traveling, position the moldboard inboard of the wheel tracks.

III. Procedures for Turning

_____ 20. Do right and left turns using wheel lean.

NOTE: Wheel lean will lower the position of the blade.

_____ 21. While in low gear and driving slowly, use the equipment controls.

NOTE: Don't make contact with surface during practice.

III. Procedures for Shutting down.

_____ 22. Bring motor grader to a stop.

NOTE: Position the grader on level ground and in a secure place.

_____ 23. Lower moldboard, scarifier, or any other hydraulically operated equipment to the ground.

_____ 24. Allow engine to idle three to five minutes at no load before shutting down.

_____ 25. Place engine-speed control in shutoff position.

_____ 26. Relieve hydraulic pressure by moving levers and steering wheel until there is no response.

_____ 27. Remove keys.

_____ 28. Dismount using grab irons and steps.

_____ 29. Make final visual inspection for leaks, broken, loose, worn, or missing parts.

_____ 30. Enter appropriate data on EMS-I

_____ 31. Report time and equipment for appropriate MMS activity number.

OJT #5-Change the Blade
Recommended Safety Equipment:

_____ 1. Hard hat

_____ 2. Gloves

_____ 3. Close-fitting clothing

Procedures:
_____ 1. Block tandem wheels, front and back.

_____ 2. Mount cab correctly and sit in operator's seat.

_____ 3. Follow starting procedures.

NOTE: Make sure parking brake is set.

_____ 4. Lower moldboard until it just touches ground with no down pressure.

_____ 5. Follow shut-down procedures and dismount using grab iron and steps.

_____ 6. Remove bolts from one section of cutting edge at a time.

_____ 7. Dislodge blade.

NOTE: Stand in a position so that the blade falls away from you off of the moldboard.

_____ 8. Clean matching surfaces with wire brush.

_____ 9. Set new section of cutting edge in place.

_____ 10. Insert bolts and secure with nuts.

NOTE: If bolts are worn, replace them.

_____ 11. Tighten bolts.

_____ 12. Remove blocks from wheels.

_____ 13. Mount machine properly and start motor grader.

_____ 14. Lower moldboard until full weight is on ground.

_____ 15. Move all controls to neutral position.

_____ 16. Follow shut-down procedures.

_____ 17. Dismount, using grab irons and steps.

_____ 18. Properly store tools and blocks; store worn cutting edges for proper disposition.

_____ 19. Report time and equipment for appropriate MMS Activity.

Alternate procedures:

_____ 1. Raise blade evenly about 8 inches above ground, place a block at each end of moldboard to change both sections at once.

_____ 2. Raise one end of moldboard until opposite end rests on ground, change one section, reverse procedures and change the other section.

_____ 3. Side shift the moldboard to one side, change one section, reverse procedures and change the other section.

OJT #6-Level 1 Servicing

_____ 1. Make a walk-around inspection for leaks, broken, worn, or missing parts.

NOTE: Major repairs and replacements should be reported to proper authority and completed by a trained mechanic.

_____ 2. Change engine oil and filter, check the box on EMS-1.

_____ 3. Check engine coolant level and strength, radiator cap, hoses, and radiator, add coolant if needed.

Caution: Don't remove radiator cap unless engine is cool; then open cap slowly to release pressure.

_____ 4. Check air cleaner restriction indicator filter, replace filter if necessary.

_____ 5. Check fuel level, fuel filters, and sediment bowl (where applicable).

_____ 6. Check battery electrolyte level, battery cables, and connectors, add water if needed.

Caution: Keep sparks and flames away from battery.

_____ 7. Check hydraulic fluid levels, filters, hoses, lines, and fittings, look for leaks, add fluid if required.

_____ 8. Check transmission fluid level, add fluid if needed.

_____ 9. Check exhaust system for loose connections and holes.

_____ 10. Check transmission pressure-line filter, fill if necessary.

_____ 11. Check brake adjustment and condition.

_____ 12. Check master-cylinder fluid level, fill if necessary.

_____ 13. Check fluid level in circle-reverse gear case, add fluid if needed.

_____ 14. Check clutch if applicable for proper adjustment.

_____ 15. Check belts for tension and condition, adjust or replace if necessary.

_____ 16. Check wiring, insulation, and connections.

_____ 17. Clean and lubricate all grease fittings according to recommendations in operator's manual.

_____ 18. Check conditions of tires.

_____ 19. Check tires pressure, inflate to recommended pressure.

_____ 20. Check all safety devices.

_____ 21. Check scarifier or other accessories.

_____ 22. Check circle drive for leaks.

_____ 23. Clean circle and lubricate according to factory recommendations.

_____ 24. Check blade and end bits, for wear, damage, loose, or missing parts.

_____ 25. Check blade linkage for excessive play, damage, loose, or missing parts.

_____ 26. Check pivot points and blade slide for dirt or debris buildup.

_____ 27. Enter all necessary information on EMS-1, check Level 1 Service.

_____ 28. Report time and materials for MMS activity number.

CHAPTER 3

OPERATING INFORMATION

This chapter describes how to use the controls and set the blade for the various jobs done in highway maintenance. Operating tips are included from experienced operators.

3.1 OPERATING TERMS

3.1.1 Control Levers

Most motor graders have control levers which change the position of the moldboard. Refer to the manufacturer's *Operating Manual* to find the control set-up for your particular model. Learn the "feel" of the blade controls to know how fast or slow they move the blade. Fighting the controls will only make the job more difficult.

The following are the controls and how they affect the blade position:

ARTICULATION: (On most machines) Lever moves the rear module from the center to the right or left. Used to turn machine in tight places.

BLADE LIFT: One on each side of the steering wheel depending on model of the grader. Right blade lift lever raises or lowers right side of the blade. Left lift lever raises or lowers left side of the blade. These settings allow for loose or tight blades.

BLADE SIDE SHIFT: Moves moldboard to right or left. This creates a better reach for the blade. It can extend the reach of the moldboard to push material over a bank when widening the shoulder, to keep grader from running on the windrow, and to keep the grader on solid ground.

> **Caution: Keep the blade away from tires when moldboard is extended.**

BLADE TILT: Lever moves blade rearward or forward, controls moldboard tilt. (See information in next section on tilt.)

CIRCLE ROTATION: Lever moves the circle clockwise or counter-clockwise. This lever changes the angle of the blade in relation to the machine. The angle is very important in determining how far material will be carried in the moldboard. A flat blade will carry material quite a distance, whereas a sharp blade will cause material to form a windrow at the heel of the blade. (See blade positions in next section.)

CIRCLE LATERAL SHIFT: Lever moves circle drawbar to the right or left. Extends moldboard to the right or left.

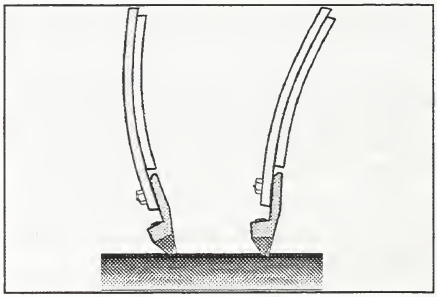
Caution: Keep blade away from tires.

WHEEL LEAN: Lever leans front wheels to the left or right. This will make it easier to turn the machine around or turn corners. Always lean the wheels in the direction that you want the machine to turn. Lean the top of the wheels in the direction you are moving the material. The wheels can be leaned to help counter side-drift created by the pull of the blade when it is loaded. When working the machine on a slope, lean the wheels up-slope to help hold the machine in a straight line. Lean the top of the wheel in the direction you are moving the material. Leaning the front wheels will lower or raise the blade slightly.

SCARIFIER: (auxiliary) Lever which raises or lowers the scarifier.

3.1.2 Moldboard Positions

PITCH: The angle for the cutting edge in relation to the road. (Figure 3.1)

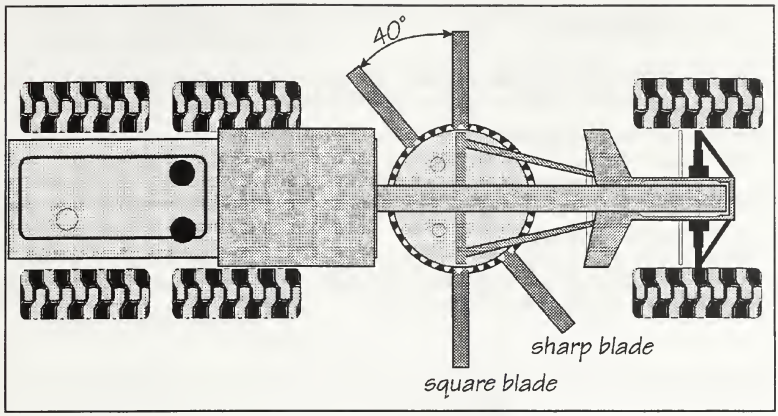


Sammie Jones-RTAP

Figure 3.1

SHARP BLADE: A blade angle in relation to a line at right angles to the machine, and will be an angle greater than 30°. Toe is near the front wheel, heel is near the back of the tandems. (Figure 3.2)

SQUARE BLADE: The blade is straight across (making a 90 degree angle with a frame) or the blade angle is 30° or less from the right angle. (Figure 3.2)



Sammie Jones-RTAP

Figure 3.2

LOOSE BLADE: Setting the blade so it just touches the surface with the weight of the blade supported by the machine.

TIGHT BLADE: Setting the blade so that it puts some down pressure on the surface.

3.2 GENERAL MOLDBOARD INFORMATION

A motor grader's moldboard can be adjusted in a variety of ways. Actual adjustment depends upon the job and materials. The moldboard can be raised and lowered as little as a fraction of an inch to adjust to the grade being finished. It can be set at any angle and pitched forward or back.

- The sharper the angle of the moldboard, the more earth will spill off the heel.
- As angle decreases, a greater amount of the load is drifted straight ahead.
- With the moldboard straight across the circle (0°), the effect is the same as bulldozing--pushing material straight ahead.
- Raising and lowering the blade determines depth of cut.
- Lowering the moldboard will stop materials from flowing underneath. All materials cut with the blade lowered will be spilled off the heel to form a windrow.

- Raising the blade determines whether material is cast into windrows or spread evenly.
- When heel of blade is raised, material will spill out underneath it and be spread along the surface by the forward motion of the moldboard.

Caution: When one end of the blade is raised, the other end will be lowered. Raising the heel too far will drive the toe into the ground.

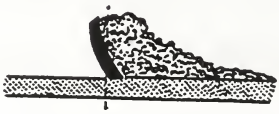
3.2.1 Pitch Adjustment

Pitch adjustment produces a cutting or dragging action. For normal grading operations, blade is kept near center of pitch adjustment so that tip of blade is directly over cutting edge.(Figure 3.3)

Oklahoma Department of Transportation

Figure 3.3

For cutting soft material, the blade is pitched backward.(Figure 3.4)



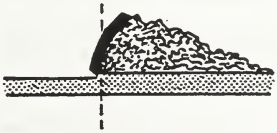
Oklahoma Department of Transportation

Figure 3.4

For mixing, laying operation, and cutting on hard surfaces; blade is pitched slightly forward. (Figure 3.5)

Oklahoma Department of Transportation
Figure 3.5

For spreading or maintaining surface material and for snow removal, the blade is pitched farther forward. (Figure 3.6)



Oklahoma Department of Transportation
Figure 3.6

3.3 GENERAL OPERATING RULES

Before starting on any job, several steps need to be followed.

1. **Make sure traffic controls are in place before beginning to work.**

> **Caution: Avoid highway accidents. Use working signs, flags, flagman, and turn on yellow flashing cab lights whenever working on road surface. Display the "Slow Moving Vehicle" emblem. Work within the traffic control zone.**

2. Walk the job looking for holes, obstructions, signs, washouts, underground utilities, and overhead obstructions.

> **Caution: Always check for water, gas, sewer lines, electrical, and telephone line locations before you start any cutting operations.**

3. Position the grader directly in front of the work.

4. Set the blade for the work to be done. The material and the grade will affect this. (More information on blade settings will be given in the upcoming sections.)

5. Select a transmission gear which will work without lugging the engine. Throttle adjustment needs to be set high enough to provide adequate oil pressure. Too much throttle will cause wheel spin.

6. Drive straight ahead.

7. Make as few changes as possible while moving on a working pass.

If the machine is set right before starting a pass, the area will be easily leveled. Try not to make changes while moving. Watch both ends of the blade when operating. Lifting one end of the blade will cause the other end of the blade to drop about 1/4 of that distance. If the circle is not level, the blade setting will change with the angle of the blade. All these factors make it difficult to change blade settings while moving. **Remember not to stop while making a pass unless absolutely necessary.**

3.4 WINDROWING

For windrowing, position the grader straight in front of the material. (Follow the steps suggested above.)

1. Set the blade position. Use a sharp blade with a tight toe and loose heel for windrowing.

2. Pitch should be at slightly forward.

3. To avoid driving over windrow, slide blade shift right so that heel is clear of left tandem drive wheel.

4. Lower toe and heel of blade to begin cutting material. All material cut with the blade lowered, will be spilled off the heel to form a windrow. Continue making windrow until reaching end of cut.

5. Stop!

6. Select reverse and back-up, (looking behind machine until returning to starting point.)

7. Move machine to the left and position right front tire to the right of previous windrow. Straddle previous windrow with motor grader.

8. Lower blade to ground to make a light grading pass, observe material flowing to left heel of blade.

9. As windrow becomes larger, top of the front tires should lean toward windrow to counteract side drift. For a heavy windrow or taking a heavy cut

use the front wheel lean. (Do not put too much load on the machine and spin the wheels. If necessary, split the windrow and make more passes.)

10. Continue process until windrow is desired size.

Wheel lean is helpful for steering and grading. Leaning wheels helps to counter side drift that can pull the front of the grader off line. However, leaning the wheels will lower the blade.

3.5 BLADE MIXING SALT AND SAND

For mixing salt and sand:

1. Spread the sand out at least the width of the blade, leaving a small windrow on each side. This will leave a smooth area several inches deep on which to spread the salt.

2. Roll the small windrows back over the top of the salt making a "sandwich" of sand, then salt, and finally sand.

3. Move to outside and pull the material out of the sandwich into small windrows. This will use the full width of the blade to roll the material.

4. Pull the small windrow into a central windrow.

5. Continue process until sand and salt are mixed.

3.6 DRYING AGGREGATE

Dry aggregate by setting the pitch so the material will roll and turn wet aggregate up to be exposed by the air. As in mixing, don't cut to deep and allow foreign materials into the aggregate. Allow plenty of room to dry. When the aggregate is dry, windrow at an even depth.

3.7 BLADE MIXING OIL AGGREGATES

Aggregate should be dried and windrowed. When mixing, always use caution not to cut too deep and get foreign materials into the mix. Always be sure to clean the area being used. Cut weeds and clear rocks before starting. Allow plenty of room. Be careful not to lengthen your windrows and keep the ends tucked in. It will be much easier to mix if the windrows are kept at an even depth. For additional information on blade mixing and related topics, refer to Appendix A, Pages 62-71 in MDOH Asphalt Pavement Maintenance Reference Manual.

Caution: Do not use back of blade for mixing. This will ruin the shift hydraulic cylinder seals.

For making mix using rigid frame grader:

1. Peel enough aggregate from the windrow to get a pad 2" to 3" thick sloped toward the wider windrow and wide enough for the distributor. (Distributor can drive on this material to help spread the asphalt.)

2. Follow the distributor, peeling more aggregate from the larger windrow covering the asphalt with a 2" to 3" lift. Successive lifts are placed in this manner until the required asphalt is layered in the material.

3. Set blade pitch forward so that the material will roll and mix thoroughly.

4. Start first pass, cutting approximately one-third of windrow material, spread this material on the mixing floor.

5. Spread the other material to be mixed on the top.

6. Continue cutting and moving windrow in portions until the required material is layered.

7. Work the material in a rolling motion until proper mix is achieved.

Procedures for articulated motor grader:

1. Pitch blade forward.

2. Articulate tandems and lean front wheels toward pile. This puts the weight of the machine behind the point of maximum load while allowing the front wheels to run on level ground.

3. Extend moldboard and circle as needed.

4. Start first pass, cutting approximately one-third of windrow material. Spread material on the mixing floor.

5. Spread the other material to be mixed on top.

6. Continue cutting and moving windrow in portions until the required material is layered.

7. Work the material in a rolling motion until proper mix is achieved.

If the material starts to "ball", put it in a large windrow and cut shallow lifts off the top. Cut through the oil balls. If the aggregate has considerable fines blending can be difficult. Lower the blade so that it presses the layer asphalt and aggregate. See MDOT video- "Blade Mixing".

3.8 BLADING AGGREGATE SURFACED ROADS

The roads need periodic maintenance to provide good ride and drainage characteristics.

1. Set up your initial pass to bring aggregate towards the center of the road. Set a flat, loose blade with the toe on the shoulder. This setting will strike off high spots and carry the spoil to deposit towards depressions. The second pass should deposit windrow just beyond the center line. The third pass should be cut from the center line towards next shoulder to form the crown. Any additional material will windrow toward the center of the roadway. This

prevents the loss of aggregate in the borrow ditch. Pay close attention to your blade to prevent problems. If the road is left flat or low in the center, water will not drain to the sides. Poor drainage creates a condition that causes early potholes and ruts.

2. Work in the direction of travel until you reach a safe turn around point, then work back to your starting point. Feather your center-line windrow to the shoulder on the second pass in either direction. Extend the blade over the shoulder to keep from building a dam on the shoulder that would disrupt drainage characteristics. Continue until windrow is spread.

These are a few cautions that warrant constant attention. Leaning the front wheels will lower the blade and establish a heavier cut.

3. Raising one end of the blade lowers the other end about 1/4 as much as the end that was raised.

4. Reversing the circle might be necessary to position the heel of the blade to deposit any spoil on the high side of a super. This keeps from filling the low side ditch with spoil.

3.9 BLADING APPROACHES

Many times there will be a high area in the center of the approach.

1. Set the machine on the oil surface and drive into the approach, cutting this high area down and carrying the material toward the right-of-way boundary. The key to this operation is driving off the oil surface at an angle so materials are moved to the correct location.

2. Stop and leave the material in a pile near the end of the area to be worked. This may require more than one pass if the material is hard.

3. Turn the machine around and pick up the pile carrying it toward the oil surface. If additional material is needed, dump it on top of the pile already formed.

4. Leave the windrow set up on the outside edge of the approach and drop any extra material in the blade in a pile on the oil surface. When setting up this windrow, use it to outline the approach.

5. Turn the machine around again and set it up in the lane of traffic which turns into the approach.

6. Pick up the pile and drive with the front wheels on the outside edge of the windrow to carry the machine into the approach without falling in the depression. This will cause the blade to lay the material in with the correct curve and angle.

7. Repeat this pass without running on the windrow, but straddling it to complete the first half of the approach. Any excess material can then be used on the other side of the approach by using the same steps.

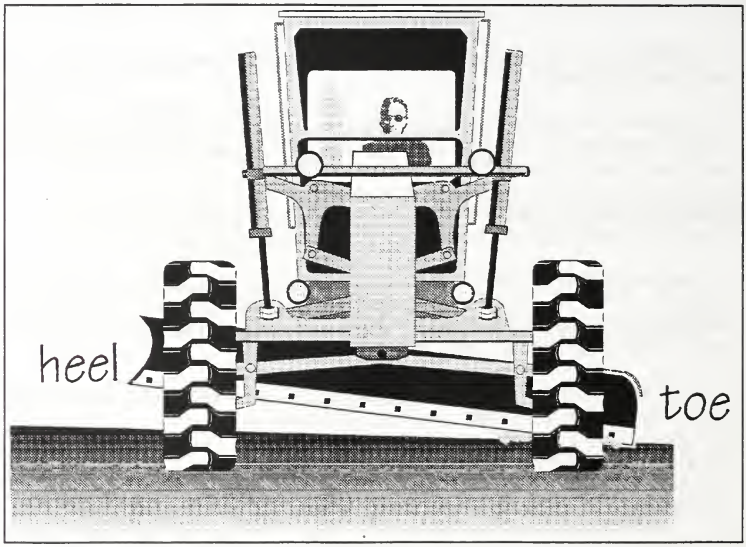
8. When completing the job, allow excess material to be strung out on the back of the approach.

9. The approach should be crowned the same as the roadway.

3.10 DITCHING

The first thing to do when cutting a ditch is to lay out a line. This can be marked with stakes visible from the cab to assist with cutting it straight.

1. When ready, angle the blade sharply and place the toe or leading edge of the blade behind the front wheel. Set the toe tight and raise the heel up.



Sammi Jones-RTAP

Figure 3.7

2. Drive the machine down the row of stakes taking a cut of 1" or 2" in depth. This is called a marker pass and will help to keep the ditch straight. Do not make this so deep that there is trouble steering the motor grader. Don't get greedy.

3. The next pass should be made with the same setting, but place the front wheel in the marker cut and put a load on the machine. Do not take more than the machine can handle. Put the motor grader in first gear and do not go too fast in case of hidden rock. These settings will deliver the windrow under the grader giving better traction.

4. The next pass, set the blade tight on both ends (Figure 3.8) to deliver the material outside of the wheels.

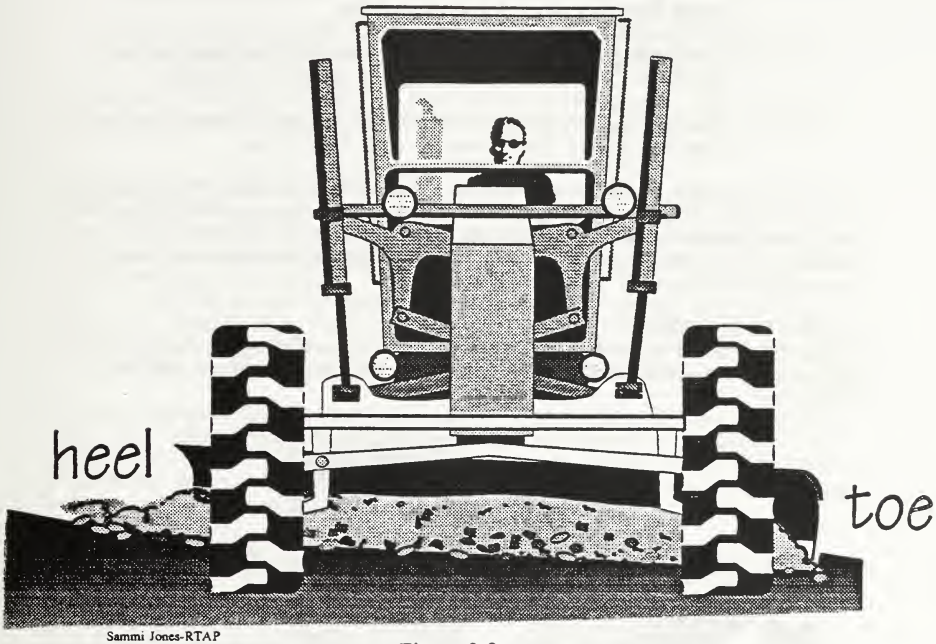


Figure 3.8

5. Next set the machine straddling the windrow and carry the windrow away from the ditch bank. Always be sure to move the windrow before it becomes so large it is awkward to handle.

6. If the ditch still needs to be deeper, repeat the steps as outlined except the marker pass. Normally when cleaning a ditch the marker pass will not be necessary.

7. Lean the front wheels up slope to help maintain a straight ditch.

If a back slope is required,

- Place one set of wheels in the ditch bottom and the other outside the ditch.
- Put the heel down with just enough angle to deliver the windrow outside of the wheels; put the toe down enough to cut the slope desired.

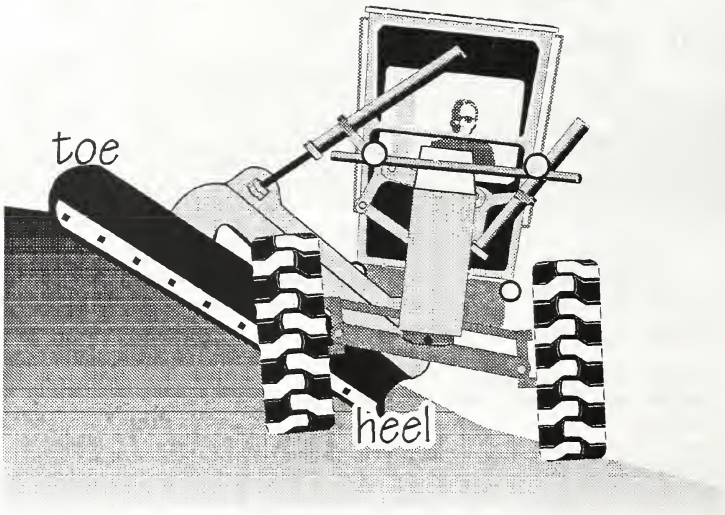
To clean the windrow out of the ditch without leaving anything in the bottom,

- Set the blade so that the toe and the heel are inside of the wheels. It should be nearly parallel with the machine.
- Drive with one wheel in the bottom of the ditch and the other on the first slope. Have both ends set tight, so as not to cut deeper.
- Then set the blade at normal sharp angle. Carry the material up the slope for disposal. This leaves the ditch bottom clean.

If a flat bottom ditch is desired, set the same as above. Remember a flat bottom ditch is on a 10:1 or 20:1 slope. The width can be set by the angle of the blade. Keep the blade level. (Watch to see if the blade will go between the wheels when it is extended.) This setting prevents material from leaking around the end and leaving some in the ditch bottom.

3.11 BACK SLOPING

Back sloping should be handled by experienced operators. If a bank is too high and steep to get the machine on, the blade may be set out to one side of the machine. (Figure 3.9)



Sammi Jones-RTAP

Figure 3.9

1. Drive along the bottom and cut the back slope in this way. On most machines this adjustment must be made by manually adjusting the moldboard

out the side. Change the location of blade attachment to the blade circle. The lift arms can then be manually lengthened. Using the side shift control, shift to the extreme side.

2. One end of the blade can be raised and the other lowered to achieve the correct setting. The cut can then be adjusted using the front wheel lean.

The final step in any ditch work is to check the ditch for drainage. This can be done with an eye level or simply by "eye-balling" it, but always make sure to check the work.

3.12 WIDENING SHOULDERS

Widening shoulders can be done in two different ways. Method one has the trucks dump material on the road surface, as in repairing a washout on a steep shoulder. Dump material in such a position that as you work, the material will be carried into the location where it is needed. Work the material out over the shoulder, leaving it high. By working the material slowly, the material will be worked into the holes. Always pull some material in towards the road and save it for finishing work. After packing the hole fully, rocks and large chunks can be separated out of the windrow. Roll these over the shoulder and use the small material to put a "finish" on the work.

The other method brings the material up on the road by cutting the slope and ditch down. The material can be carried up on the road and finished as previously outlined. To separate large rocks out of material in a windrow, set the blade 3" or 4" above the ground. This will leave the finer material and carry the rock and larger material into a separate windrow.

3.13 SCARIFYING

Scarifier is used for shallow loosening of road surface. The procedures for scarifying are on the OJT #14-Scarifying.

3.14 SNOW PACK AND ICE

Snow pack and ice create special hazards for the motor grader. To prevent problems, chain up. If the machine is not all-wheel drive, reverse the front wheels so the tread is opposite to that on the drive wheels. Always drive straight and do not use so much down pressure that the front wheels are raised to a point that steering is ineffective. Be careful of manhole covers, water shut-offs, expansion joints which can catch the blade and suddenly cause abrupt changes of direction.

Proceed as follows:

1. Tip moldboard forward.

2. Rotate circle to sidecast material.

3. Line up left front wheel of motor grader on center line of road.

4. Lower blade to just touch pavement, and lean wheel in direction of sidecast snow.

5. Plow from center line to shoulder. Make sure that the plow will clear a path for the grader's wheels.

6. Clean snow past intersections.

7. Clean roadway--don't leave a windrow in the main roadway.

8. Plow to low side of ramps or curves.

9. Maintain safe operating speed.

10. Adjust blade to road conditions. (For wet or heavy, snow, set blade at a sharp angle.)

11. Be aware of flow of snow and its hazard to bridges, barriers, walkways. Adjust speed and spacing accordingly.

12. Be aware of problems caused by blade angles, blade tilt, packed ice, traffic, and sight distances.

13. Set blade to empty as soon as it can. Do not carry snow on plow.

14. Check blade edge for wear.

15. When the destination is reached, raise the blade and turn the machine around.

16. Line up left side, place wheel on grade area, lower blade, and continue to remove snow.

On-the-Job Training List

OJT #7 -Making a Windrow

_____ 1. Follow pre-start inspection procedures.

_____ 2. Mount motor grade using steps and handles.

_____ 3. Follow procedures for starting engine.

_____ 4. Sit in operator's seat and fasten seat belt.

_____ 5. Follow operation procedures.

_____ 6. Proceed to work area.

_____ 7. Circle blade left to position toe of blade behind right front tire.

_____ 8. To avoid driving over windrow, slide blade shift so that heel is clear of left tandem drive wheels.

_____ 9. Lower toe and heel of blade to begin cutting material.

NOTE: As desired depth is reached, material should flow freely to heel of blade and form the windrow.

_____ 10. Continue making windrow until reaching end of cut.

_____ 11. Raise blade clear of ground and stop.

_____ 12. Select reverse and back up--looking behind machine--until reaching starting point.

_____ 13. Move machine to the left and position right front tire to right of windrow-straddling the windrow.

_____ 14. Lower blade to ground to make a light grading passes, observe material flowing to left heel of blade.

_____ 15. As windrow becomes larger, the top of the front tires should lean the same direction you are moving the windrow to counteract side drift.

NOTE: Leaning the wheels will lower the blade and shift it slightly in the direction.

_____ 16. Continue process until windrow is desired size.

_____ 17. Return to parking area, stop and secure motor grader, follow shut down procedures.

_____ 18. Dismount grader carefully.

_____ 19. Follow final inspection procedures.

_____ 20. Complete EMS-1 and MMS Sheets.

OJT # 8-Drying Aggregate

_____ 1. Follow start-up procedures.

_____ 2. Review *Operator's Manual* for specific instruction.

_____ 3. Follow safety procedures for operating grader.

_____ 4. Follow start up and operation procedures.

_____ 5. Raise all implements and proceed to work area.

Procedures for rigid-frame motor grader:

_____ 1. Pitch blade forward.

NOTE: This blade position will create a rolling and mixing action in material.

_____ 2. Start first pass, cut out a manageable amount of material and spiral it into windrow.

_____ 3. Continue cutting and moving material back and forth until it is surface dry. By creating a lot of small windrows across the floor, you increase the drying area and pitch of the material to the sun and wind.

Procedures for an articulated motor grader:

_____ 1. Pitch blade forward.

_____ 2. Articulate tandems and lean front wheel toward pile.

NOTE: This puts the weight of machine behind the point of maximum load while allowing the front wheels to run on level ground.

_____ 3. Extend moldboard and circle as needed.

_____ 4. Start first pass, cut out a manageable amount of material and spiral it into a windrow.

_____ 5. Continue cutting and moving material back and forth until it is surface dry.

OJT #9-Blade Mixing

_____ 1. Follow pre-operation and start-up procedures.

_____ 2. Follow safety procedures.

_____ 3. Follow operation procedures.

_____ 4. Pitch blade forward.

NOTE: The blade position will create a rolling and mixing action in the materials.

_____ 5. Start first pass, cutting approximately one-third of windrow material, spread this material on the mixing floor.

_____ 6. Spread the other material to be mixed on top.

_____ 7. Continue cutting and moving windrow in portions until the required material is layered.

_____ 8. Work the material in a rolling motion until proper mix is achieved.

Procedure for an articulated motor grader.

_____ 9. Pitch blade forward.

_____ 10. Articulate tandems and lean front wheels toward pile.

NOTE: This puts the weight of the machine behind the point of maximum load while allowing the front wheels to run on level ground.

_____ 11. Extend moldboard and circle as needed.

_____ 12. Start first pass, cutting approximately one-third of windrow material, spread material on the mixing floor.

_____ 13. Spread the other material to be mixed on top.

_____ 14. Continue cutting and moving windrow in portions until the required material is layered.

_____ 15. Work the material in a rolling motion until proper mix is achieved.

_____ 16. Return to parking place, stop grader, follow shut down procedures, and secure motor grader.

_____ 17. Check for loose parts, leaks, damaged blade, clean off material which has built up on the circle, front axle, and other parts.

_____ 18. Report problems to Supervisor.

_____ 19. Report production on MMS.

OJT #10-Grading Aggregate Surface Roads

_____ 1. Follow pre-start inspection procedures.

_____ 2. Review *Operator's Manual* or specific instructions.

_____ 3. Mount motor grader, using steps and grabbing irons.

_____ 4. Sit in operator's seat and secure seat belt.

_____ 5. Follow procedure for starting engine; allow proper warm up.

_____ 6. Check all gauges and controls for proper functioning.

_____ 7. Set engine-speed control as suggested in the *Operations's Manual.*

_____ 8. Position gearshift lever in proper gear.

_____ 9. Raise all implements.

_____ 10. Release the parking brake; proceed to work area.

_____ 11. Make sure traffic-control devices are in place.

NOTE: Don't work beyond the effective distance of your signing.

_____ 12. Downshift to working speed.

_____ 13. Set a flat blade with moderate angle to carry the material.

NOTE: Use moderate down pressure to shave the high spots and carry that material to low spots.

_____ 14. Position motor grader to grade from right barrow ditch or shoulder toward center of road on first pass.

_____ 15. Lower blade to desired depth of cut when motor grader is in position.

NOTE: Start on right side of road with toe of blade at bottom of barrow ditch or at edge of shoulder.

_____ 16. Begin grading, windrow aggregate at roadway center.

_____ 17. At end of graded section, raise blade and turn motor grader around.

_____ 18. Begin grading, windrow aggregate at roadway center.

_____ 19. At end of graded section, raise blade and turn motor grader around.

_____ 20. Repeat the same process returning on the other side of the road continue back to starting point.

_____ 21. At end of graded section, raise blade and turn motor grader around.

_____ 22. Set necessary blade angle with the toe of blade back of left front wheel.

_____ 23. Position the motor grader to grade from the crown toward the shoulder, don't waste aggregate in the barrow ditch.

NOTE: If road is left flat or low in the center, water will not drain to the sides. Poor drainage creates a condition that causes early potholes and ruts.

_____ 24. Move motor grader off pavement to a safe level parking place.

_____ 25. Set the emergency brake.

_____ 26. Lower blade to the ground.

_____ 27. Inspect the work.

_____ 28. Return to parking area; stop and secure motor grader; follow shutdown procedures.

_____ 29. Dismount, using grab irons and steps.

_____ 30. Make final visual inspection for leaks, broken, worn, loose, or missing parts.

_____ 31. Enter appropriate data on EMS-1.

_____ 32. Report time and production for MMS Activity Number 1108

OJT #11-Grading Approaches

_____ 1. Follow pre-start inspection procedures.

_____ 2. Review *Operator's Manual* or specific instructions.

_____ 3. Mount motor grader, using steps and grabbing irons.

_____ 4. Sit in operator's seat and secure seat belt.

_____ 5. Follow procedure for starting engine; allow proper warm up.

_____ 6. Check all gauges and controls for proper functioning.

_____ 7. Set engine-speed control as suggested in the *Operator's Manual*.

_____ 8. Position gearshift lever in proper gear.

_____ 9. Raise all implements.

_____ 10. Release the parking brake; proceed to work area.

_____ 11. Make sure all traffic-control devices are in place.

_____ 12. Approaches should be crowned at .02/feet and also have a 6% slope. Set machine on oil surface in center of approach; drive into approach striking off any high spots and carry excess material to a pile at the end of the work area.

_____ 13. Raise the blade and turn around.

_____ 14. Pick up the pile and carry it toward the oiled surface.

NOTE: If additional material is needed, dump it on the pile you already have.

_____ 15. Set up a small windrow to outline each side of the approach.

_____ 16. Turn around on the oil to enter the approach at an angle.

_____ 17. Spread the material in the windrow across the approach from each side.

_____ 18. Excess material can be spread out on the back of the approach.

_____ 19. Move motor grader off pavement to a safe level parking place.

_____ 20. Set the emergency brake.

_____ 21. Lower blade to the ground.

_____ 22. Inspect the work.

_____ 23. Return to parking area; stop and secure motor grader; follow shutdown procedures.

_____ 24. Dismount, using grab irons and steps.

_____ 25. Make final visual inspection for leaks, broken, worn, loose, or missing parts.

_____ 26. Enter appropriate data on EMS-1.

_____ 27. Report time and production for MMS Activity Number 2104.

OJT #12-Ditch Construction

_____ 1. Follow pre-start inspection procedures.

_____ 2. Review *Operator's Manual* or specific instructions.

_____ 3. Mount motor grader, using steps and grabbing irons.

_____ 4. Sit in operator's seat and secure seat belt.

_____ 5. Follow procedure for starting engine; allow proper warm up.

_____ 6. Check all gauges and controls for proper functioning.

_____ 7. Set engine-speed control as suggested in the *Operator's Manual.*

_____ 8. Position gearshift lever in proper gear.

_____ 9. Raise all implements.

_____ 10. Release the parking brake; proceed to work area.

_____ 11. Operate side shift to extreme left.

NOTE: With an articulated motor grader, articulate so that tandems run outside of the "V" where traction is better.

_____ 12. For cutting a ditch on the side of road, move in the same direction as the traffic. Rotate circle until toe of blade is directly behind right front wheel.

_____ 13. Raise left lift cylinder to full up.

_____ 14. Lower right blade-lift cylinder to set blade tip for desired depth of cut.

_____ 15. Lean front wheels to left and make a 4 inch to 5 inch cut.

NOTE: Leaning will counteract side drift of blade. Keep blade toe in line with outside edge of lead tire while maintaining a straight line.

_____ 16. Continue cutting to desired depth, keeping front tire in bottom of ditch.

NOTE: Each ditch cut should be made as deep as possible with blade toe in line with center of lead tire, and without stalling grader.

_____ 17. Continue ditching and bringing successive cuts in from the edge of the bank slope; blade toe will be in line with bottom of ditch on final cut.

_____ 18. Move motor grader off pavement to a safe level parking place.

_____ 19. Set the emergency brake.

_____ 20. Lower blade to the ground.

_____ 21. Inspect the work.

II. Procedures for wet-ditch grading with an articulated motor grader.

NOTE: This procedure may be used for wet ditch grading, or to avoid obstructions when cleaning old ditches that may have tree overhangs, or rock ledges.

_____ 1. Articulate motor grader so that front wheels and blade are in the ditch.

_____ 2. Steer with front wheels.

_____ 3. Keep rear wheels on shoulder to prevent wheels from slipping in wet or soft material in ditch.

_____ 4. Return to parking area; stop and secure motor grader; follow shutdown procedures.

_____ 5. Dismount, using grab irons and steps.

_____ 6. Make final visual inspection for leaks, broken, worn, loose, or missing parts.

_____ 7. Enter appropriate data on EMS-1.

_____ 8. Report time and production for MMS Activity Number 3106.

OJT #13-Snow Removal

_____ 1. Follow pre-start inspection procedures.

_____ 2. Review *Operator's Manual* or specific instructions.

Caution: Steps and irons could have ice on them.

_____ 3. Mount motor grader, using steps and grabbing irons.

_____ 4. Sit in operator's seat and secure seat belt.

_____ 5. Follow procedure for starting engine; allow proper warm up.

_____ 6. Check all gauges and controls for proper functioning.

_____ 7. Set engine-speed control as suggested in the *Operator's Manual.*

_____ 8. Position gearshift lever in proper gear.

_____ 9. Raise all implements.

_____ 10. Release the parking brake; proceed to work area.

_____ 11. Downshift to working speed.

_____ 12. Pitch moldboard forward.

_____ 13. Rotate circle to sidecast material.

_____ 14. Line up left front wheel of motor grader on center line of road.

_____ 15. Lean wheels in direction of sidecast snow.

_____ 16. Lower blade to touch pavement.

NOTE: Excessive down pressure reduces steering and traction.

_____ 17. Continue removing snow until destination is reached.

NOTE: Check blade wear frequently during operation to prevent moldboard damage.

_____ 18. Raise blade and turn machine around.

_____ 19. Reposition motor grader on opposite side of road for return pass.

_____ 20. Line up left side, placing wheel on grade area.

_____ 21. Lower blade to pavement and continue snow removal while making any adjustments necessary to avoid scarring road.

_____ 22. Return to parking area; stop and secure motor grader; follow shutdown procedures.

_____ 23. Dismount, using grab irons and steps.

_____ 24. Make final visual inspection for leaks, broken, worn, loose, or missing parts.

_____ 25. Enter appropriate data on EMS-1.

_____ 26. Report time and production for MMS Activity Number.

OJT #14-Scarify

_____ 1. Read *Operator's Manual.*

_____ 2. With ball peen hammer, insert full set of teeth (usually eleven) in scarifier.

_____ 3. Follow pre-start inspection procedures.

_____ 4. Review operator's manual or specific instructions.

_____ 5. Mount motor grader, using steps and grab irons.

_____ 6. Sit in operator's seat and secure seat belt.

_____ 7. Following procedure for starting engine; allow proper warm up.

_____ 8. Check all gauges and controls for proper functioning.

_____ 9. Set engine-speed control as suggested in the *Operator's Manual.*

_____ 10. Position gearshift lever in proper gear.

_____ 11. Raise all implements.

_____ 12. Release the parking brake; proceed to work area.

_____ 13. Be sure that all traffic-control devices are in place.

_____ 14. Position grader about 20 feet from starting point on right side.

_____ 15. Lower scarifier log until teeth are about 2 inches above pavement.

_____ 16. Shift transmission into low range.

_____ 17. Move forward at a speed that allows you to reach operating speed and lower scarifying teeth to desired cutting depth at starting point.

NOTE: If motor grader lugs or stalls, there are two options; reduce the depth of the cut or remove a tooth or teeth from each side of the log. Always take the same number of teeth from each side of the log to balance applied force.

_____ 18. Continue scarifying in a straight line; any side torque can break off teeth.

NOTE: If teeth have a tendency to ride to top of the road surface, adjust pitch nearer to 90° to the pavement. This adjustment can be made while the motor grader is moving. See *Operator's Manual.*

_____ 19. When end of scheduled distance to be scarified is reached, raise teeth 4 inches to 6 inches above the pavement.

_____ 20. Turn the grader around.

NOTE: If the scarifier log is mounted in front of the front wheels, turn grader in the normal way. If the log is mounted behind the front wheels, rotate the blade while teeth are in scarifying position.

_____ 21. Repeat steps.

_____ 22. Continue until entire width of the surface has been scarified.

_____ 23. Raise teeth to travel height.

_____ 24. Move motor grader off pavement to a safe level parking place.

_____ 25. Set the emergency brake.

_____ 26. Lower blade to the ground.

_____ 27. Inspect the work.

_____ 28. Return to parking area; stop and secure motor grader; follow shutdown procedures.

_____ 29. Dismount, using grab irons and steps.

_____ 30. Make final visual inspection for leaks, broken, worn, loose, or missing parts.

_____ 31. Report time and production for the MMS.

CHAPTER 4

BLADE PATCHING

Always keep in mind that the major objective of a blade patch is to level the area, to give motorist a good ride, and to leave a good appearance. A good patch makes snow plowing easier, too. To accomplish this, the shoulder lines need to be straight, neatly tapered at ends, and provide for a smooth transition to the original surface. Plan the locations for the ends of the patches. Adjust the length to avoid ending in a depression.

4.1 PATCH PREPARATION

- Try to start and stop a patch on level ground.

- Clean the shoulders. If the shoulder is higher than the mat, cut the shoulder down level with the mat so water can drain away.

- Tight blade depressions to bring to normal elevation. Cut off high spots and clean any cracked or broken oil mat out of the hole/holes. It may be necessary to sweep some dust or dirt off to achieve a good bond. The surface must be clean in order for an asphalt tack coat to stick on the mat.

- Decide the condition of the road.

  ✓ For rough roads, deeply rutted roads, alligator, or severe cracks, level out low spots, and spread the tack coat on the area to be repaired. Dump the mix on the tack coat.

  ✓ For other roads, dump the mix on dry pavement, then tight blade the mix into a windrow on the edge of the pavement. Apply the tack and tight blade the mix into the tack area. Apply the rest of the tack, then establish the edges and spread the patch.

  ✓ Areas with a high concentration of rich material which ruts a lot, can be cut and leveled, bladed without a tack and then sealed.

- Extend the patch a short distance on each end to taper the ends.

- Take all material to be wasted off in the borrow pit and spread it out so that it is not a hazard to mowers. This also leaves a good appearance.

- Shoot tack a little wide so there wouldn't be any rough edges. Edge of road needs to taper to prevent a drop off or poor drainage.

4.2 PATCH MATERIAL

The type of material used will affect your procedures to a great degree. The type normally used is mixed with a "cut back" asphalt. (A cut back asphalt is simply one that has an agent added to make it workable at a low temperature. A medium cure

asphalt is used as this can be left in the stockpile for quite awhile. Lighter grades of medium cure are used when cool weather is encountered. Heavier asphalt should not be used when materials are to be stockpiled for long periods.

Aggregates with large amounts of fines will be hard to lay. This material is a "fluffy" or "sticky" type of pre-mix that tends to drag along the road without going under the blade. Fluffy pre-mix must be laid in deep lifts and rolled after every pass.

Hot plant mix using asphalt cement must be worked at very high temperature. Hot plant is used mostly with a lay down machine, but sometimes may be laid using a grader. As it cools, this asphalt becomes unworkable. So work rapidly with this mix.

Try to lay the hot plant mix with AC oil in three passes before the material becomes unworkable. It is important to lay the material in lifts. Hot plant mix can be spread from the truck very evenly, so the first pass sets up the shoulder line. Lay the mix back one pass and then dress to the outside. This will complete laying the load in three passes. (On a hot afternoon, you might get four trips. But for best results do it in three.) If it is a wide road, lay it in strips and dump a small amount on the center of the lift and dress it right to the edge to complete the finished surface.

In doing a patch, remember angle, pitch, and pressure of the blade. A flat blade will tend to level more than a sharp blade, but it may tear the patch. A sharp blade is more apt to cut into the pavement. The amount of angle used will depend on the amount of heat and moisture in the mix, and the type of materials used to produce mix. For example, on a hot afternoon a much flatter blade can be used than on a cloudy morning.

A video, *Blade Patching*, is available from the MDT Resource Center.

4.3 HALF ROAD PATCH

The key to laying a good patch is getting control of the berm. Think ahead about the pass you're making--How much material will be moved in this pass? (A little less works better.) What is the weather like and how will that affect the mix? What is the mix like? What should the angle of the blade and pitch be? What gear and speed would be best for this windrow? Where will the end of the patch be?

Keep one step ahead of your work. The fewer adjustments you make, the better your patch will be. Use accelerator\decelerator pedals for patches. Both cylinders on moldboard need to be straight up and down.

4.3.1 Windrowing Mix

Using articulation to turn around and approaching the material head on gives better control of the material. Driving straight ahead also gives better visibility, avoids back blading, and gives operator better blade control.

1. Even out mix from the dump trucks. (If truck drivers dump evenly and smoothly, this step will be simple.) Operate with a moderately flat, straight, loose blade for the first pass. The flat blade will tend to even out mix which is not

dumped evenly. The loose setting helps to prevent cutting into the old mat and breaks up chunks in the mix.

2. Turn around. (Don't turn on the patch.) Drive forward lining up the grader to straddle the windrow. Go to a sharp, tight blade. The heel of the blade will carry the material back to the starting end of the patch and will also help to break up any chunks in the mix. The material should be in the approximate center next to center line on your side of the road. This will take 3-4 passes.

3. Turn around; carry a windrow to the other side of the road setting up a shoulder line. Drive forward and line the grader up so that the machine is straddling the windrow. Have the windrow fall where the edge of the patch should be sitting on the edge of the existing mat. Allow a few inches for when the blade picks up the windrow. It will force some material to the shoulder.

Windrow position is very important. Be sure you do not put the material out too far towards the shoulder. (If material is lost over the shoulder, do not try to retrieve it. Dirt and rocks might contaminate the patch.) Tuck the windrow at the end of the patch.

The windrow may be tucked with an articulated grader. When at the end of the tack, turn and articulate the front of grader into the windrow. (Turning the circle toward the windrow will also help tuck the windrow. Slide the blade in so you don't cut the tires.) This will straighten the end of the windrow past the end of the tack.

4. The windrow should be straight and even in size so the mix will fall in a straight line when leaving the blade. A deep hole might need more material. In this case, allow extra room to hold a straight line on the outside of the windrow. Consistency of windrow will make or break a patch. Be sure to protect the windrow as you lay the patch.

4.3.2 Setting the Shoulder Line

Be careful that the mix coming out of the blade will not fall under the rear wheels. Don't stop in the middle of a pass. Use a consistent speed (2-3 mph.)
This is the most important pass of the patch.

1. Turn the machine around and approach the patch from the opposite direction. Always stop close to the end of the patch and on level road. Set the toe of the blade with a sharp, loose blade directly behind the outside front wheel (prevents material from going out the toe) so the mix will be delivered outside the tandems. Straddle the windrow.

Note: Some operators feel that an operator should not drive on the windrow as this will leave a ridge. They feel the windrow should be brought back with the toe. Sometimes this will take two passes. Check techniques out with your trainer or master motor grader operator.

2. Drive forward putting the front wheel slightly up on the side of the windrow. Put 1/4 of tire or less on the windrow. (This is the only time you will run the

grader on the windrow.) Line the grader up. Tap the blade a little bit more on the windrow and drive a little higher on berm. The blade will pick up the pile as you drive up on the windrow. This will raise the blade slightly, making the taper for that end and packing the edge line. The edge of a level pass serves as a guide for the rest of the passes.

3. Drive straight and the same height up on the windrow all the way across the patch. This will leave a level area even though it was not level at the start. Running the tire on the edge of the windrow will carry the grader level across holes and high spots. The edge of the windrow will pack so material does not run off toe of the blade, ruining the straightness of the shoulder line.

4. Gradually edge back down on the shoulder edge. This will lower the blade, putting the taper on this end.

5. Cut the wheels when the end of the tack is reached. The blade will pick up the pile, raising the blade slightly, making a taper at the end, and packing the edge line.

4.3.3 Building the Crown

Carry the mix back to the center of the road.

1. Even out the windrow.

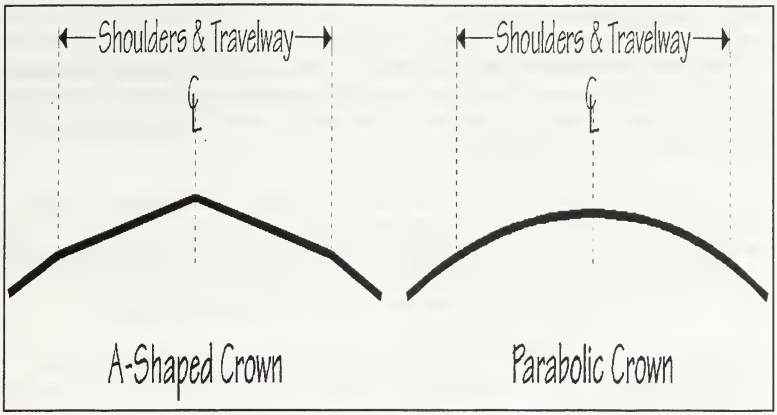
2. Set the blade sharp for this pass. The pitch should be at a 90°. Set the blade loose with the toe leaving about 2" above the surface of the road and the heel about 2 1/2" above the surface. This helps to build the tapers and the crown.

3. Straddle the windrow. Lower the blade. (Leaning the front wheels toward the toe of the blade will also set the taper. It might be better for inexperienced operators not to use wheel lean.) Center the windrow between the two front tires. This helps to build the crown. Don't drive on windrow on this pass.

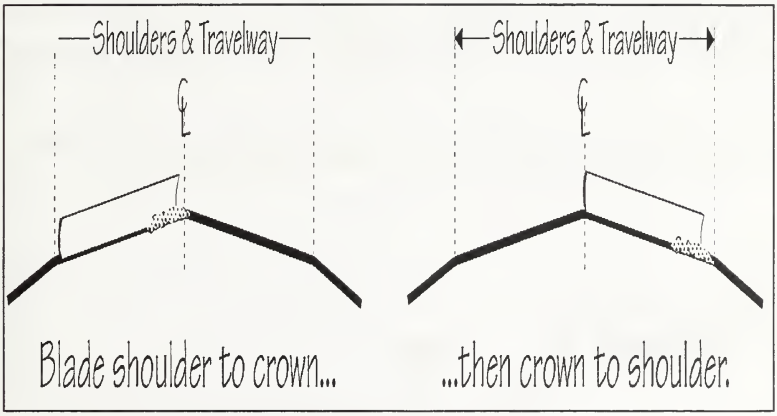
4. Drive forward watching the blade. Keep an eye on the toe. Raise the toe of the blade and then the heel when the blade has enough material. (This is the point to straighten front wheels when doing wheel lean.) This will raise both ends of the blade following the taper started by the first lift. The blading action should be float, slice, and compact. (See illustration 4.1)

5. As you come toward the end of the patch, drop the heel and then the toe to taper off end of the patch. When finishing a patch, wheels shouldn't be in a leaning position as this will create a trough and ridge.

6. Turn into the direction of the windrow and tuck the mix in.



Sammie Jones-RTAP



Sammie Jones-RTAP

Figure 4.1

4.3.4 Finish Work

1. Approach the patch stopping on level road. You should have laid approximately two-thirds of the amount of mix that was dumped on the patch. Use the rest of the material to put a finish on the surface of the patch. Lower the blade for the taper and set the blade at a sharp angle.

2. Use the rest of mix to finish the surface of the patch. Use a sharp, tight blade. Any chunks will be carried by the blade eliminating drag marks. Lay about 1/2 of the material in this pass. The material should run out just before reaching the end of the patch and there will be no pile left. Back up and repeat the same pass straddling the windrow with the heel just even with the edge of the patch.

3. Let a very small amount of material roll off the edge along with the chunks. This will insure that all drag marks will be filled and the surface will be even and clear across the patch.

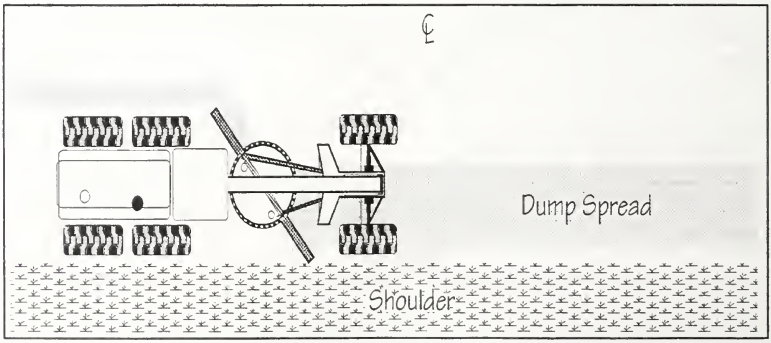
4. Roll the chunks down by leaving them along the edge. This leaves a good appearance to the patch.

5. To straighten the end of the patch, the operator may use a shovel and rake.

4.4 WORKING FROM THE SHOULDER LINE

On tapered sections that change from one roadway width to another, or where you wish to re-establish a straight shoulder line, sometimes it is easier to work from the shoulder than the center line. Establish a windrow from the dump spread approximately two feet from the shoulder; uniformity or exact distance is not crucial at this point.

Position the grader with the outside wheels right on the shoulder with a tight blade, sharp enough to cast the windrow beyond the inside wheels.(Figure 4.2)



Sammie Jones-RTAP

Figure 4.2

This pass should run straight down the shoulder establishing the windrow at a uniform distance from the shoulder. Turn around changing the blade setting, drive back down the shoulder line again (Figure 4.3). This pass puts the windrow in line with the shoulder, and in position for the spread pass.

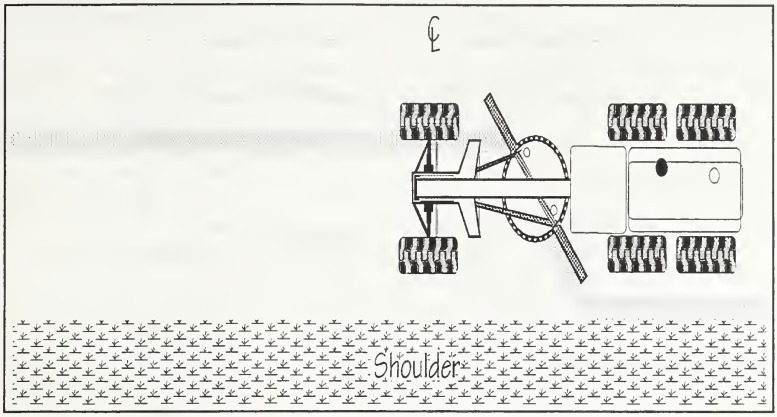


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Figure 4.3

When the material does not run out perfectly, take the windrow back to the center and then complete the patch. If this is necessary, do not carry the windrow clear to the edge. Leave room to put a wheel between the windrow and the edge and carry it back. Never come clear out to the edge until the patch is ready to finish.

If a small pile of mix is left at the end of the patch, blend this back over the patch. Do not string it out down the road. If there is a lot of material left, shoot some more tack coat and put mix on this. Do not blade mix off into the ditch and waste it.

Always make as few passes as possible so the material will not separate. Too much working will separate the rocks and fines. Rocks will whip off the surface. Blade pitch is important. The pitch should be set to force the material under the blade to make the surface tighter. Too much pressure will tear the patch. Be sure that the toe of the blade is set correctly. If it is too loose, a ridge will be formed where the blade picks up the windrow.

These are the basic steps in laying any patch. Following the basics and practicing will help you get a good patch.

4.5 FULL ROAD PATCHES

Full road patches may be accomplished by shooting tack coat on one side and windrowing the dumped material to the center. The other side can then be tacked and the material carried on across. By the time the other side of the shoulder is reached, the material should be in position to set up the shoulder line.

1. Begin laying material as outlined. When reaching the center, blade material across and set up the shoulder line.

2. Again lay material to the center of the road. The remaining pre-mix can then be used to finish either side, depending on where it is needed, using the steps outlined for finish work.

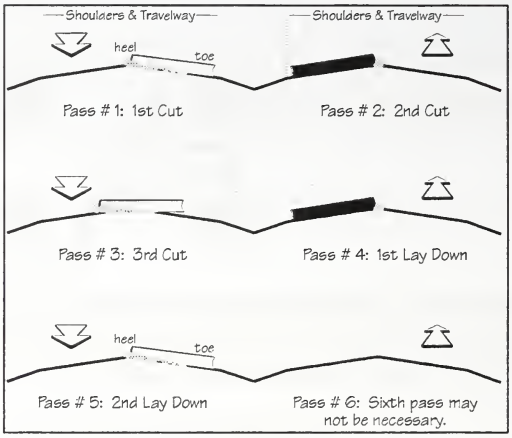

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Figure 4.4

4.6 HALF-SOLE PATCHES

A half-sole is just a long patch, and the same steps are followed as in the half road patch. One difference is that a half-sole is laid out in sections. When choosing a point to turn around, be sure to pick a spot where the grader can be easily turned off the road surface. Do not turn the machine around on fresh laid oil mix as the tandems will tear it. Blend the ends back over the first section to eliminate all joint traces.

4.7 DIPS

A short deep dip may be laid using a short cut.

1. Extend the tack coat about a truck length on each side of the dip. Tin cans or any type of marker can be set on the shoulder to mark where the dip begins and ends. The pre-mix may be dumped in one pile.

2. Drive over the pile taking as much material as possible and dropping the pre-mix into the dip.

3. Back up and set the blade with a tight and sharp angle to the shoulder. Pick up all the rest of the material and set up the shoulder line.

4. Begin to lay the patch. The material that is put in the hole will support one front tire and the windrow will support the other.

5. Ease the front wheel higher on the windrow when coming to the markers.

6. Ease down at the other marker to run the end taper.

7. Finish the patch using the same methods as above. The advantage to working slowly is that the grader will not have to be turned around as often.

4.8 ROAD CENTER PATCHES

On patches where a shoulder line does not have to be formed, such as a hole in the center of the road,

1. Spread the material to one edge of the tack with a tight blade.

2. Straddle the windrow and leave the toe tight to the road.

3. Drive forward, raise the heel slightly to begin laying material. Set both edges in this manner.

When waiting for trucks or doing a long patch,

4. Lay the loads back toward the work that is finished and blend the ends back over the finished work, being careful not to leave any bumps.

4.9 BRIDGE ENDS

When patching a bridge end, set the shoulder windrow up so that it is very small as you come to the bridge.

1. When driving the windrow and approaching the bridge, run up on top of small part and avoid the bridge rail.

2. Always lay towards the bridge on the shoulder cuts. Then follow the normal steps for the rest of the patch.

3. Run the taper from the end of the patch up to the bridge and make the rise gradual over the entire length of the patch. A gradual taper will prevent a jolting "bump" in front of the bridge.

4.10 CATTLE-GUARDS

Patching cattle-guards requires caution as material can be easily lost down the hole.

1. Watch the toe of the blade when approaching the cattle-guard.

2. When the material in front of the blade is close to the rails, use the circle blade reverse to flatten the blade so material will be pushed up close all along the length of the blade.

3. Raise the blade and drive far enough forward to position the blade on the other side of the pile.

4. Lower the blade and back up. This will carry the material away from the cattle-guard to be blended back over the patch.

5. Handle both sides of the road in the same way.

4.11 SHARP CURVES

When patching on sharp curves, ride higher on the windrow to allow for the tandems dropping down on the edge of the material as you turn.

4.12 PATCH COMPACTION

The last step in laying a patch is to compact it by rolling. This will prevent loss of surface material due to "kick off" from high speed traffic and increase durability of the patch. It is best to use a roller. If one is not available, roll the material down with trucks to reduce the voids and raveling.

1. Roll the shoulder first and work the material toward the center of the road. If roller has a steel drum, allow 4" to 6" to hang over the shoulder but avoid letting the roller drum "tilt" back and forth as this will spoil the shoulder line.

2. Avoid turning the roller on the fresh patch.

3. Roll the patch after it is completed. The exception would be a very deep hole. A small hole can be rolled with the grader wheel but on a large one a roller can be used.

4. Lay the material to the center and then roll the material on this lift. Another lift can be laid over this. Where heavy traffic might cause excessive packing or settling, deep lifts may be rolled individually.

5. If the material is more than .2 feet deep, lay it in equal lifts. It is best to roll small areas with the motor grader wheels, so that when the patch has stopped settling, it will be level.

6. Over rolling a patch will force material out of a hole. About two trips across the patch will usually set the material in place. This may vary depending on the weight and type of roller.

7. Compaction is very critical element in asphalt pavement maintenance. Time and temperature can become important considerations because as the mix cools it becomes more difficult to work. Compaction usually involves three phases.

Phase One "Compression" or "Breakdown" passes are the first passes aimed at reducing the voids in the mix and expelling as much air as possible.

Phase Two "Intermediate" rolling is the process that positions the particles and compacts the material. A further purpose of this intermediate compaction is to stabilize the mass to minimize distortion by traffic.

Phase Three "Finish" rolling is to establish the final surface and remove any marks from prior rolling.

Be sure to roll each lift as it is being put down. If the asphalt cools too much, the roller will not be able to compact the asphalt. (Rolling cold mix is different from rolling A.C. hot mix.) If the lifts are too deep, wait to put the roller on the hot material so that the roller will not push the material out of the hole.

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VIDEOS

Taking Control of Your Motor Grader (John Deere)-19 min.

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Blade Mixing (MDT-1989)- 6 min.

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Motor Grader Operation Part I, II, & III.-13 min.